BELLCOMM, INC.

SUBJECT: Existence of a Favorable 1976 Dual-Planet Ballistic Flyby Case 103-2

DATE: February 14, 1967

FROM: H. S. London
A. A. Vander Veen

## ABSTRACT

A dual-planet ballistic flyby of Venus and Mars was found corresponding to a launch date late in 1976. Analysis shows that several of its mission parameters compare favorably with those of Mars twilight flybys and other dual-planet flybys currently known to exist.

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MEMORANDUM FOR FILE

A dual-planet ballistic flyby of Venus and Mars was found corresponding to a launch date late in 1976. Analysis shows that several of its mission parameters compare favorably with those of Mars twilight flybys and other dual-planet flybys currently known to exist. Table I shows the mission characteristics.

TABLE I

| EVENT | DATE (Julian) | DATE (Calendar) | V-inf (emos) | PASS. RAD. (p.r.) | PASS. VEL. (fps) | ΔV (fps) |
|---|---|---|---|---|---|---|
| Earth Dep. | 244 3081 | 30 Oct. 76 | .2144 | | | 16,200 |
| Venus Pass. | 244 3312 | 18 Jun. 77 | .2182 | 1.430 | 35,330 | |
| Mars Pass. | 244 3501 | 24 Dec. 77 | .1518 | 1.138 | | |
| Earth Arr. | 244 3795 | 14 Oct. 78 | .4017 | | | 53,300 |

This dual-planet flyby is a special case of the outbound Venus swingby-Mars stopover mission corresponding to the 1978 Mars-Venus alignment.[1] The swingbys associated with this opportunity are of Type #5[2], which generally reveal at least one relatively high-energy leg due to timing incompatibilities at Mars. Zero stopover time reduces the incompatibility.

The Mars-Earth return leg comes very close to Venus' orbit (perihelion distance ∿.72 a.u.). It is therefore likely that the 1977 triple planet flyby (launch in February, 1977) is a special case of the 1976 dual-planet flyby.

The dual-planet ballistic flyby presented here offers definite advantages over the single planet Mars Twilight flybys currently under consideration:

1. Less meteoroid protection need be provided because the maximum spacecraft excursion from the Sun is only about 1.6 a.u., vs 2.28 a.u. for the twilight flyby.

2. Much lower passage velocity at Mars. This eases the unmanned probe deployment and MSSR constraints.

These favorable properties are common to other multiplanet flybys. The 1976 dual-planet mission, however, has the additional favorable characteristics:

1. Low passage speed at Venus - ∿.22 emos, vs .35 emos for either the 1975 or 1978 dual-planet flybys.

2. Perihelion distance of about .68 a.u., vs about .54 for the 1975 or 1978 dual-planet missions - this reduces the maximum solar heat flux.

Disadvantages of the 1976 dual-planet flyby are:

1. Higher Earth return speed - about 53,300 fps, vs 48,000 fps for the 1975 Mars twilight flyby.

2. Approximately 700 fps greater Earth injection ΔV required, as compared to the 1975 Mars twilight flyby.

3. About one month longer duration than the 1975 Mars twilight flyby.

It should be borne in mind that the data presented here is the result of a very "quick" look into the existence of dual-planet flybys and should not be construed to represent an optimized mission. Investigation in depth may reveal more favorable trajectories, which may eliminate one or more disadvantages expressed above. On the other hand, the existence of usable "windows" remains to be seen.

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A. A. Vander Veen

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Attachment:
References

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## REFERENCES

1. Deerwester, J. M., "Initial Mass Savings Associated with the Venus Swingby Mode of Mars Round Trips," AIAA Second Aerospace Sciences Meeting, Paper No. 65-89, 1965.

2. Gillespie, R. W. and Ross, S., "The Venus Swingby Mission and Its Role in the Manned Exploration of Mars," AIAA Third Aerospace Sciences Meeting, Paper No. 66-37, 1966.